RICE Work Group Chair/Co-Chair

ICCR RICE Source Work Group

Attached are the HAPs Selection and Test Method tables for natural gas fuel fired reciprocating internal combustion engines. These lists contain the names of the 189 Hazardous Air Pollutants (HAPs) that have, based on experience, been screened for potential presence in emissions from reciprocating internal combustion engines. This preliminary screening has been performed by the Testing and Monitoring Protocol Work Group (TMPWG). These tables are being forwarded to the Reciprocating Internal Combustion Engine Source Work Group (SWG) for review and comment.

The table includes HAPs that may be present in reciprocating internal combustion engine emissions. Additionally, a listing of testing methods that have been used and have the potential to quantify the HAPs presence in flue gas emissions are included.

For those HAPs that are not included in the list, a codified reason for their exclusion is provided. Exclusion codes include:

> 1- Compound is not expected to be emitted from source because basic chemical or physical principles do not favor its existence in source exhaust.
>
> 2 - Existing test data indicate that compound is not emitted in significant quantities from source.

Other exclusion codes are included as appropriate.

It should be noted that this table is general in its first draft and represents the extent of the TMPWG's knowledge and experience with emissions from reciprocating internal combustion engines. Please review carefully from a standpoint of those HAPs included as well as those HAPs excluded. The subgroup within the TMPWG that is responsible for the development of this table has included a preface that provides the sources of information utilized to develop the table, the rationale for exclusion codes, and the names of the TMPWG contact for the Reciprocating Internal Combustion Engine SWG.

If we can be of service in any other fashion or if you have any questions concerning in the table, please contact William Passie, the TMPWG's member who is monitoring the activities of your SWG.

HAP Selection and Test Methods for Natural Gas Fired Reciprocating Internal Combustion Engines

The attached HAPS Selection and Test Methods for Natural Gas Engines identifies analytical procedures of interest in determining significant HAPS emissions. The 10 chemicals that were included in the list are the most likely to be significant to the ICCR rule making process. The chemicals were obtained from the AP-42 emission factor list. Inclusion on this list is not intended to imply that these substances will in fact be emitted from all engines, but we believe that they potentially could be emitted from some engines at rates that exceed 0.1 ton/year. Subsequent reviews or measurements by the Source Work Group will better define emission rates for the different types and sizes of engines.

Chemicals that were excluded for measurements were done on the basis of measurements by the Gas Research Institute ["Measurements of Air Toxic Emissions from Natural Gas-fired Internal Combustion Engines at Natural Gas Transmission and Storage Facilities", Report No GRI-96/0009.1]. The emissions of these chemicals were measured to be less than 0.1 ton/year.

Other chemicals were excluded on generally known chemical principles. Chlorine and bromine containing chemicals were excluded on the basis of no chlorine or bromine atoms being present during the combustion. Insecticides, herbicides and other industrial chemical intermediates were excluded on the basis of not being in the fuel, and chemical conditions not being favorable for their formation during combustion.

		HAPS Selection and Test Methods for Source Category		
Source Category:		Natural Gas RIC Engines		
Include in List	**CAS No.**	**Chemical name**	**If excluded, give reason for exclusion (use codes where appropriate)**	**If Included, give applicable test method(s)**
X	75070	Acetaldehyde		FTIR
	60355	Acetamide	1	Method(s)?
	75058	Acetonitrile	1	Method(s)?
	98862	Acetophenone	1	Method(s)?
	53963	2-Acetylaminofluorene	1	Method(s)?
X	107028	Acrolein		FTIR
	79061	Acrylamide	1	Method(s)?
	79107	Acrylic acid	1	Method(s)?
	107131	Acrylonitrile	1	Method(s)?
	107051	Allyl chloride	1	Method(s)?
	92671	4-Aminobiphenyl	1	Method(s)?
	62533	Aniline	1	Method(s)?
	90040	o-Anisidine	1	Method(s)?
	1332214	Asbestos	1	Method(s)?
X	71432	Benzene		EPA Method TO-14
	92875	Benzidine	1	Method(s)?
	98077	Benzotrichloride	1	Method(s)?
	100447	Benzyl chloride	1	Method(s)?
	92524	Biphenyl	2	CARB 429
	117817	Bis(2-ethylhexyl)phthalate (DEHP)	1	Method(s)?
	542881	Bis(chloromethyl)ether	1	Method(s)?
	75252	Bromoform	1	Method(s)?
	106990	1,3-Butadiene	1	Method(s)?
	156627	Calcium cyanamide	1	Method(s)?
	133062	Captan	1	Method(s)?
	63252	Carbaryl	1	Method(s)?
	75150	Carbon disulfide	1	Method(s)?
	56235	Carbon tetrachloride	1	Method(s)?
	463581	Carbonyl sulfide	1	Method(s)?
	120809	Catechol	1	Method(s)?
	133904	Chloramben	1	Method(s)?
	57749	Chlordane	1	Method(s)?
	7782505	Chlorine	1	Method(s)?
	79118	Chloroacetic acid	1	Method(s)?
	532274	2-Chloroacetophenone	1	Method(s)?
	108907	Chlorobenzene	1	Method(s)?
	510156	Chlorobenzilate	1	Method(s)?
	67663	Chloroform	1	Method(s)?
	107302	Chloromethyl methyl ether	1	Method(s)?
	126998	Chloroprene	1	Method(s)?
	1319773	Cresols/Cresylic acid (isomers and mixture)	1	Method(s)?
	95487	o-Cresol	1	Method(s)?
	108394	m-Cresol	1	Method(s)?
	106445	p-Cresol	1	Method(s)?
	98828	Cumene	1	Method(s)?
	94757	2,4-D, salts and esters	1	Method(s)?
	3547044	DDE	1	Method(s)?
	334883	Diazomethane	1	Method(s)?
	132649	Dibenzofurans	1	Method(s)?
	96128	1,2-Dibromo3-chloropropane	1	Method(s)?
	84742	Dibutylphthalate	1	Method(s)?
	106467	1,4-Dichlorobenzene(p)	1	Method(s)?
	91941	3,3-Dichlorobenzidene	1	Method(s)?
	111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	1	Method(s)?
	542756	1,3-Dichloropropene	1	Method(s)?
	62737	Dichlorvos	1	Method(s)?

		HAPS Selection and Test Methods for Source Category		
Source Category:		Natural Gas RIC Engines		
Include in List	**CAS No.**	**Chemical name**	**If excluded, give reason for exclusion (use codes where appropriate)**	**If Included, give applicable test method(s)**
	111422	Diethanolamine	1	Method(s)?
	121697	N,N-Diethyl aniline (N,N-Dimethylaniline)	1	Method(s)?
	64675	Diethyl sulfate	1	Method(s)?
	119904	3,3-Dimethoxybenzidine	1	Method(s)?
	60117	Dimethyl aminoazobenzene	1	Method(s)?
	119937	3,3--Dimethyl benzidine	1	Method(s)?
	79447	Dimethyl carbamoyl chloride	1	Method(s)?
	68122	Dimethyl formamide	1	Method(s)?
	57147	1,1-Dimethyl hydrazine	1	Method(s)?
	131113	Dimethyl phthalate	1	Method(s)?
	77781	Dimethyl sulfate	1	Method(s)?
	534521	4,6-Dinitroo-cresol, and salts	1	Method(s)?
	51285	2,4-Dinitrophenol	1	Method(s)?
	121142	2,4-Dinitrotoluene	1	Method(s)?
	123911	1,4-Dioxane (1,4-Diethyleneoxide)	1	Method(s)?
	122667	1,2-Diphenylhydrazine	1	Method(s)?
	106898	Epichlorohydrin (l-Chloro-2,3-epoxypropane)	1	Method(s)?
	106887	1,2-Epoxybutane	1	Method(s)?
	140885	Ethyl acrylate	1	Method(s)?
X	100414	Ethyl benzene		TO-14
	51796	Ethyl carbamate (Urethane)	1	Method(s)?
	75003	Ethyl chloride (Chloroethane)	1	Method(s)?
	106934	Ethylene dibromide (Dibromoethane)	1	Method(s)?
	107062	Ethylene dichloride (1,2-Dichloroethane)	1	Method(s)?
	107211	Ethylene glycol	1	Method(s)?
	151564	Ethylene imine (Aziridine)	1	Method(s)?
	75218	Ethylene oxide	1	Method(s)?
	96457	Ethylene thiourea	1	Method(s)?
	75343	Ethylidene dichloride (1,1-Dichloroethane)	1	Method(s)?
x	50000	Formaldehyde		FTIR
	76448	Heptachlor	1	Method(s)?
	118741	Hexachlorobenzene	1	Method(s)?
	87683	Hexachlorobutadiene	1	Method(s)?
	77474	Hexachlorocyclopentadiene	1	Method(s)?
	67721	Hexachloroethane	1	Method(s)?
	822060	Hexamethylene-1,6-diisocyanate	1	Method(s)?
	680319	Hexamethylphosphoramide	1	Method(s)?
	110543	n-Hexane	2	EPA METHOD TO-14
	302012	Hydrazine	1	Method(s)?
	7647010	Hydrochloric acid	1	Method(s)?
	7664393	Hydrogen fluoride (Hydrofluoric acid)	1	Method(s)?
	7783064	Hydrogen sulfide	1	Method(s)?
	123319	Hydroquinone	1	Method(s)?
	78591	Isophorone	1	Method(s)?
	58899	Lindane (all isomers)	1	Method(s)?
	108316	Maleic anhydride	1	Method(s)?
	67561	Methanol	2	EPA METHOD TO-14; FTIR
	72435	Methoxychlor	1	Method(s)?
	74839	Methyl bromide (Bromomethane)	1	Method(s)?
	74873	Methyl chloride (Chloromethane)	1	Method(s)?
	71556	Methyl chloroform (1,1,1-Trichloroethane)	1	Method(s)?
	78933	Methyl ethyl ketone (2-Butanone)	1	Method(s)?
	60344	Methyl hydrazine	1	Method(s)?
	74884	Methyl iodide (Iodomethane)	1	Method(s)?
	108101	Methyl isobutyl ketone (Hexone)	1	Method(s)?
	624839	Methyl isocyanate	1	Method(s)?

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Include in List	**CAS No.**	**Chemical name**	**If excluded, give reason for exclusion (use codes where appropriate)**	**If Included, give applicable test method(s)**
	80626	Methyl methacrylate	1	Method(s)?
	1634044	Methyl tert butyl ether	1	Method(s)?
	101144	4,4-Methylene bis(2-chloroaniline)	1	Method(s)?
	75092	Methylene chloride (Dichloromethane)	1	Method(s)?
	101688	Methylene diphenyl diisocyanate (MDI)	1	Method(s)?
	101779	4,4--Methylenedianiline	1	Method(s)?
X	91203	Naphthalene		SW-846 OR CARB 429
	98953	Nitrobenzene	1	Method(s)?
	92933	4-Nitrobiphenyl	1	Method(s)?
	100027	4-Nitrophenol	1	Method(s)?
	79469	2-Nitropropane	1	Method(s)?
	684935	N-Nitroso-Nmethylurea	1	Method(s)?
	62759	N-Nitrosodimethylamine	1	Method(s)?
	59892	N-Nitrosomorpholine	1	Method(s)?
	56382	Parathion	1	Method(s)?
	82688	Pentachloronitrobenzene (Quintobenzene)	1	Method(s)?
	87865	Pentachlorophenol	1	Method(s)?
	108952	Phenol	2	SW-846 OR CARB 429
	106503	p-Phenylenediamine	1	Method(s)?
	75445	Phosgene	1	Method(s)?
	7803512	Phosphine	1	Method(s)?
	7723140	Phosphorus	1	Method(s)?
	85449	Phthalic anhydride	1	Method(s)?
	1336363	Polychlorinated biphenyls (Aroclors)	1	Method(s)?
	1120714	1,3-Propane sultone	1	Method(s)?
	57578	beta-Propiolactone	1	Method(s)?
	123386	Propionaldehyde	1	Method(s)?
	114261	Propoxur (Baygon)	1	Method(s)?
	78875	Propylene dichloride (1,2-Dichloropropane)	1	Method(s)?
	75569	Propylene oxide	1	Method(s)?
	75558	1,2-Propylenimine (2-Methyl aziridine)	1	Method(s)?
	91225	Quinoline	1	Method(s)?
	106514	Quinone	1	Method(s)?
	100425	Styrene	2	EPA TO-14
	96093	Styrene oxide	1	Method(s)?
	1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1	Method(s)?
	79345	1,1,2,2-Tetrachloroethane	1	Method(s)?
	127184	Tetrachloroethylene (Perchloroethylene)	1	Method(s)?
	7550450	Titanium tetrachloride	1	Method(s)?
X	108883	Toluene		EPA TO-14
	95807	2,4-Toluene diamine	1	Method(s)?
	584849	2,4-Toluene diisocyanate	1	Method(s)?
	95534	o-Toluidine	1	Method(s)?
	8001352	Toxaphene (chlorinated camphene)	1	Method(s)?
	120821	1,2,4-Trichlorobenzene	1	Method(s)?
	79005	1,1,2-Trichloroethane	1	Method(s)?
	79016	Trichloroethylene	1	Method(s)?
	95954	2,4,5-Trichlorophenol	1	Method(s)?
	88062	2,4,6-Trichlorophenol	1	Method(s)?
	121448	Triethylamine	1	Method(s)?
	1582098	Trifluralin	1	Method(s)?
	540841	2,2,4-Trimethylpentane	1	Method(s)?
	108054	Vinyl acetate	1	Method(s)?
	593602	Vinyl bromide	1	Method(s)?
	75014	Vinyl chloride	1	Method(s)?
	75354	Vinylidene chloride (1,1-Dichloroethylene)	1	Method(s)?

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Include in List	**CAS No.**	**Chemical name**	**If excluded, give reason for exclusion (use codes where appropriate)**	**If Included, give applicable test method(s)**
X	1330207	Xylenes (isomers and mixture		EPA TO-14
X	95476	o-Xylenes		EPA TO-14
X	108383	m-Xylenes		EPA TO-14
X	106423	p-Xylenes		EPA TO-14
	N/A	Antimony Compounds	2	SW-846
	N/A	Arsenic Compounds (inorganic including arsine)	2	SW-846
	N/A	Beryllium Compounds	2	SW-846
	N/A	Cadmium Compounds	2	SW-846
	N/A	Chromium Compounds	2	SW-846
	N/A	Cobalt Compounds	2	SW-846
	N/A	Coke Oven Emissions	1	Method(s)?
	N/A	Cyanide Compounds *1	1	Method(s)?
	N/A	Glycol ethers *2	1	Method(s)?
	N/A	Lead Compounds	2	SW-846
	N/A	Manganese Compounds	2	SW-846
	N/A	Mercury Compounds	2	SW-846
	N/A	Fine mineral fibers *3	1	Method(s)?
	N/A	Nickel Compounds	2	SW-846
	N/A	Polycylic Organic Matter *4	2	CARB 429
	N/A	Radionuclides (including radon) *5	1	Method(s)?
	N/A	Selenium Compounds	2	SW-846